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Pre-operative serum albumin and neutrophil-lymphocyte ratio are associated with prolonged hospital stay following colorectal cancer surgery

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Abstract

Aims—Colorectal cancer is the third most common cancer in European populations. It has been shown previously that neutrophil-lymphocyte ratio (NLR), pre-operative albumin, and haemoglobin are useful prognostic indicators. The aim of this study was to assess how these factors influence the length of postoperative stay (LOS) following colorectal cancer surgery.

Methodology—All patients undergoing elective colorectal resections for malignancy between 2010 and 2011 in Pilgrim Hospital, Boston, U.K. were considered for the study. Hospital archive systems were used to ascertain pre-operative NLR, albumin and haemoglobin levels. LOS was calculated from electronic discharge documents with day 1 being the day after surgery. Unifactorial and multifactorial analyses were performed to identify independent predictors of prolonged stay

Results—196 patients were included in the study. Pre-operative haemoglobin was not associated with prolonged hospital stay. On univariate analysis, pre-operative serum albumin and pre-operative NLR were associated with prolonged hospital stay. On multivariate analysis, pre-operative serum albumin >34.5 g/dl (odds ratio, 0.47; 95% confidence interval, 0.24 – 0.92; p = 0.027) retained independent association for prolonged hospital stay .However, pre-operative NLR failed to reach statistical significance on multivariate analysis.

Conclusions—Patients with low albumin and elevated NLR are more likely to have an increased hospital stay following colorectal cancer surgery. This may be useful for surgeons in terms of identifying the 'high-risk' patient post-operatively and allow for early intervention.

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AUTHORS' CONTRIBUTIONS

BT designed the study and performed the statistical analysis. RG collected the data, managed the analyses of the study and wrote the first draft of the manuscript. MR collected the data, managed the analyses of the study. All authors read and approved the final manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Keywords

Colorectal cancer; neutrophil-lymphocyte ratio; serum albumin; length of post-operative stay

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1. INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer in European populations and with population ageing, the number of new cases is expected to rise [1]. Colorectal excisional surgery is associated with postoperative pain, paralytic ileus and reduced pulmonary function. These factors contribute to patients requiring short-term inpatient postoperative care [2]. Major elective colorectal surgery is also associated with a morbidity rate of 15–20% that can lead to extended admission [3-5]. Optimal admission duration, from a healthcare provider's viewpoint, is the minimal required stay prior to safe home discharge. Duration of hospital stay represents a surrogate marker of patient recovery.

The length of postoperative stay contributes significantly to the cost of general surgical care. A single day's stay on a surgical ward costs approximately £220 and on a high-dependency unit £550 [6]. Postoperative stay has been a target for cost-cutting, but there is insufficient understanding of the pre-operative factors that lengthen postoperative stay.

The overall prognosis of CRC patients is mainly dependent on several factors: pathological, clinical and biological. To date, a number of studies have been extensively conducted to explore the role of pre-operative prognostic factors for survival in patients with CRC. In particular, neutrophil:lymphocyte ratio (NLR) [7,8], pre-operative albumin [9,10], and haemoglobin[11,12] were shown to be useful prognostic indicators. This study aims to investigate if these prognostic factors of CRC also influence the length of postoperative stay following colorectal excisional surgery.

2. MATERIAL AND METHODS

The study group consisted of 223 consecutive patients who underwent colorectal resection as elective or emergency procedures at Pilgrim Hospital, Boston, Lincolnshire, U.K. There were no exclusion criteria. This was performed over a 24-month period from 2010–2011. A conventional open surgical technique was used in all cases. Patients left hospital only when: (i) they had opened their bowels; (ii) they had passed urine; (iii) they were capable of changing a stoma bag, if needed; and (iv) social circumstances were satisfactory for discharge. General anaesthesia was used for all cases.

Information collected about patient characteristics includes sex, age, primary tumour site and stage of disease. Data was also collected on whether the surgery was done as an elective or emergency procedure. Hospital archive systems were used to ascertain pre-operative NLR, albumin and haemoglobin levels. LOS was calculated from electronic discharge documents with day 1 being the day after surgery.

2.1 Statistical Analysis

Data are presented as median with interquartile range in parenthesis unless otherwise stated.

LOS was categorized into approximate quartiles based on all cases. Since there is no national, or internationally agreed, definition of prolonged LOS following colorectal resection, we defined prolonged hospital stay as duration greater than the upper-quartile for all cases (> 15 days). Multivariable logistic regression was used to identify factors which predicted a prolonged hospital stay. Receiver-operator characteristic curves were used to select cutoff values for continuous variables. Values with the best combination of sensitivity and specificity were chosen. A backward stepwise procedure was done to derive a final model of the variables that had a significant relationship with prolonged hospital stay. To remove a variable from the model, the corresponding P value had to be >0.1. P values <0.05 were regarded as statistically significant. Statistical analysis was done using SPSS 15.0 statistical package (SPSS Inc.).

3. RESULTS AND DISCUSSION

Of the 223 patients identified, 196 patients had sufficient data to be included in the study. Details of these 196 patients are presented in Table 1. The median length of post-operative stay is 10 days (interquartile range 7 – 15 days). 13.8% of the operations were performed on an emergency basis.

On univariate analysis, pre-operative serum albumin and pre-operative NLR were associated with prolonged hospital stay (Table 2). Using receiver-operator characteristic curves, the cutoff values with the best discriminatory value for pre-operative serum albumin was >34.5 g/dl, and >4.3 for pre-operative NLR. On multivariate analysis, pre-operative serum albumin >34.5 g/dl (odds ratio, 0.47; 95% confidence interval, 0.24 – 0.92; $p = 0.027$) retained independent association for prolonged hospital stay (Table 2). However, pre-operative NLR failed to reach statistical significance on multivariate analysis.

There was a significant correlation between pre-operative serum albumin and length of hospital stay ($r = -0.176$, $p = 0.013$, Spearman's ρ)

4. CONCLUSION

This study revealed that pre-operative serum albumin and neutrophil-lymphocyte ratio were associated with increased LOS for both emergency and elective admissions in patients undergoing colorectal excisions for colorectal cancer.

Serum albumin level has shown to be a marker of disease severity [13], and hypoalbuminemia is associated with the presence of a systemic inflammatory response and weight loss [14,15]. The present study's findings are consistent with previous studies linking poor nutritional status with an adverse postoperative course in patients undergoing surgical treatment for colorectal cancer [16,17].

Although NLR was not a significant predictor of LOS in the multivariate analysis, it was still associated with LOS in the univariate study. NLR is an index of the systemic inflammatory response [18]. In various stressful events the physiological response of circulating leucocytes is characterized by an increase in neutrophil counts and a decline in lymphocyte counts [19]. NLR has a significant association with prevalent chronic conditions

such as hypertension and diabetes mellitus [20]. Given its association with chronic conditions, it is perhaps not surprising that NLR has been shown to correlate with an increased risk of complications following colorectal surgery and medium term survival in patients with colorectal cancer.

Interestingly, the length of hospital stay was not associated with emergency procedures or with advancing patient age.

The current study has several limitations. There is heterogeneity in the cohort as we included patients who underwent rectal procedures. However, there was no significant difference in increased length of hospital stay regardless of the operation performed. Pre-operative co-morbidity was not analysed in this study. Nevertheless, this study has shown that pre-operative albumin and NLR are associated with prolonged hospital stay following colorectal excision for colorectal cancer.

Clearly, patients with low albumin and elevated NLR are more likely to have an increased hospital stay following colorectal cancer surgery perhaps through developing post-operative complications. This may be useful for surgeons in terms of identifying the ‘high-risk’ patient post-operatively and allow for early intervention.

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Table 1

Patient demographics

	No. of patients (n=196)
Age (years) †	72.1[65.1 – 79.0]
Sex	
M	119 (60.7)
F	77 (39.3)
Length of Stay (days) †	10 [7 – 15]
Operation performed	
Right/Left hemicolectomy	70 (35.7)
Sigmoid colectomy	45 (23.0)
Anterior resection	58 (29.6)
Abdomino-perineal resection	11(5.6)
Total colectomy	12 (6.1)
Stage	
Tis	8 (4.1)
I	23 (11.7)
II	74 (37.8)
III	66 (33.7)
IV	20 (10.2)
Unknown	5 (2.6)
Pre-operative haemoglobin (g/dl) †	12.3 [10.7 – 13.9]
Pre-operative white cell count ($\times 10^9$/l) †	7.5 [5.7 – 9.6]
Pre-operative serum albumin (g/l) †	35 [29 – 39]
Pre-operative Neutrophil:Lymphocyte ratio †	3.76 [2.53 – 6.39]
Emergency procedures	27 (13.8)

Values are number of patients with percentages in parentheses unless indicated otherwise

† values are median with interquartile range in square parentheses

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Table 2

Odds ratio for increased length of hospital stay (>15 days) associated with clinical variables in patients undergoing colorectal resection (n=196)

	Univariate analysis			*Multivariate analysis*		
	Odds Ratio	**95% C.I**	***P*** *	**Odds Ratio**	**95% C.I**	***P*** **
Age	1.031	0.996 – 1.067	0.087			
Sex	0.804	0.409 – 1.582	0.528			
Operation performed	1.035	0.786 – 1.364	0.806			
Stage of disease	1.349	0.939 – 1.940	0.106			
Pre-operative Haemoglobin	1.057	0.905 – 1.235	0.482			
Pre-operative White cell count	1.049	0.979 – 1.123	0.174			
Pre-operative serum albumin	0.949	0.906 – 0.995	0.031			
>34.5 g/l				0.472	0.243 – 0.918	0.027
Pre-operative neutrophil:lymphocyte ratio (NLR)	1.072	1.003 – 1.147	0.041			
>4.3				1.664	0.831 – 3.332	0.151
Emergency procedure	1.667	0.694 – 4.004	0.253			

* Simple logistic regression analysis

** Multivariate logistic regression analysis using the backward conditional model